NUMERICAL CALCULATION OF TSUNAMI PROPAGATION INTO OSAKA BAY

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Contributions, Geophysical Institute, Kyoto University, No. 13, 1973, 139-146

REPORTS

NUMERICAL CALCULATION OF TSUNAMI PROPAGATION INTO OSAKA BAY

By

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(Received August 31, 1973)

Abstract

Equations of tsunami propagation were solved analytically with simple initial and boundary conditions. But these days we can solve them with complex conditions numerically due to the development of electric computers. In this report which considers the damage from tsunami caused by great earthquakes (for example 1946 Nankaido earthquake), the wave forms along the coast of Osaka Bay are obtained according to the numerical solution of differential equations with the approximation of the long wave. The boundary condition of a sine wave with the period of 30, 60 and 120 min. are used in the mouth of Kii Channel, and the resonance in Osaka Bay is examined with each condition.

Since antiquity great earthquakes similar to the 1944 Tonankai and 1946 Nankaido earthquakes which caused damage in and near the Kinki district have occurred every hundred years. And tsunamis which accompanied these great earthquakes caused more severe damage around Osaka Bay and Kii Channel. The following is the results of a numerical calculation of these tsunamis.

A number of research of a numerical calculation of tsunami have been done by I. Aida. Theoretical wave forms resembling the observed tide gauge records can be calculated by initial water elevation (I. Aida [1969]), and we can presume the water elevation vice versa (I. Aida [1972]). On the other hand, Fitch et al. [1969] proposed the fault model, and vertical and horizontal displacement at the time of the 1946 Nankaido earthquake with the data from the leveling survey.

We can not make sure that their results are alike from the actual sea bottom deformation. So the author calculated the water level of tsunami produced by their vertical displacement model according to Aida's method. Fig. 1 (lower) shows the adopted computing grid scheme. Hatched areas are tsunami sources by Fitch et al. [1971], which is modified for this numerical calculation. It is important to examine whether the computed wave forms coincide with the actual tide gauge records or not. Since the latter is not available, we must use another means to compare the two. In Fig. 2 the maximum computed values of wave height and the observed ones at the coast of Shikoku and Kii Pen. are plotted with a solid line and a broken line respectively. The computed heights and the observed ones of tsunami differ remarkably at least

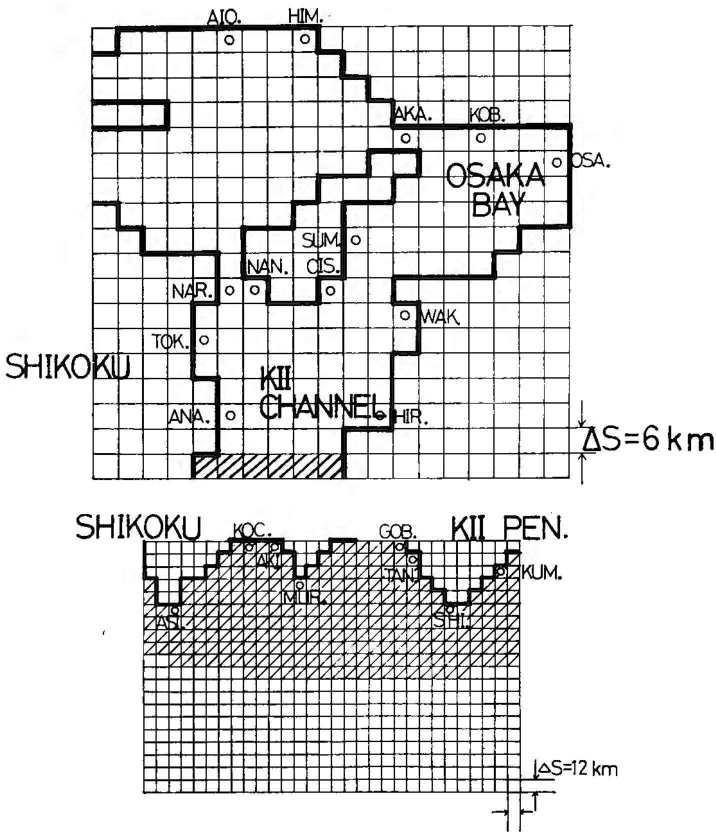

Fig. 1. Computing grid scheme.
(upper) The area in and near Osaka Bay. A sine wave is given in the hatched area as the boundary condition.
(lower) This area is used in the calculation of the 1946 Nankaido earthquake. Vertical displacement model by Fitch et al. (1971) is adopted in the hatched area as the initial condition.

with the distribution of maximum height; namely the former is almost twice as tall as the latter at the south coast of Shikoku, and vice versa near Shionomisaki. The maximum uplift area is set at the offing of 120–130 km from Kochi in their model, but it should be moved eastward.

In order to investigate the tide effects in Kii Channel and Osaka Bay, a more general means is adopted instead of their model. Namely, the elevation which has 5 m in amplitude and the periods of 30 min. (Fig. 3 A) 60 min. (Fig. 3 B) and 120 min. (Fig. 3 C) are given successively as the boundary condition at the entrance of Kii Channel—hatched area in Fig. 1 (upper). The boundary height of tsunami at the entrance of Kii Channel is assumed as 5 m amplitude in this study, since the maximum amplitude in Kii Channel has been reported 5.5 m in the time of tsunami accompanied by the 1946 Nankaido earthquake. The height of tsunami in Osaka Bay increase

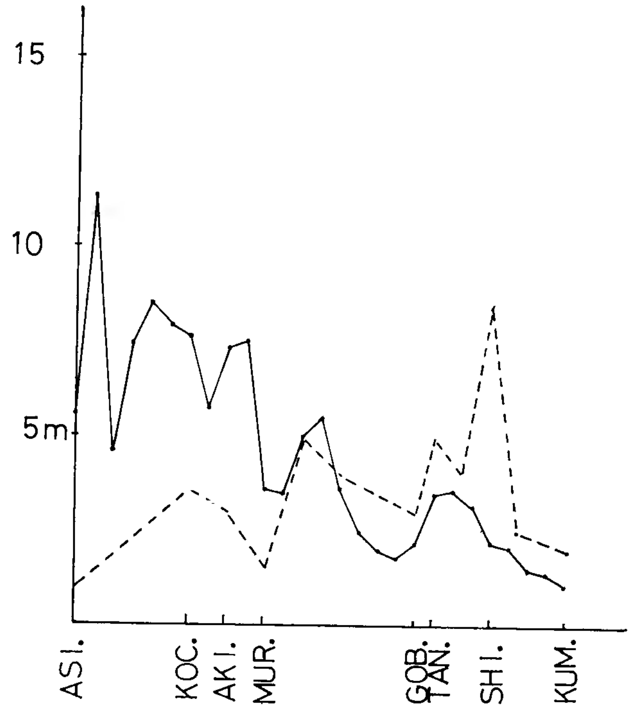

Fig. 2. The distribution of maximum heights at various points in Fig. 1 (lower) along the coast of Shikoku and Kii Pen.. The solid and broken lines indicate the computed and observed height respectively.

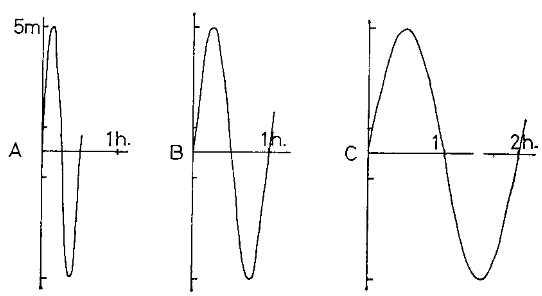

Fig. 3. The sine wave which is given at the entrance of Kii Channel — hatched area in Fig. 1 (upper) — as the boundary condition.

almost in proportion to the displacement at the entrance of Kii Channel. The degree of resonance in the bay is affected mainly by the period of the input wave, so the calculation is made at the case of the period 30, 60 and 120 min. The distribution of maxumum heights within 6 hours are shown in Fig. 4. And the wave forms of tsunami produced by these elevations are indicated in Fig. 5. When the period is 30 min., the

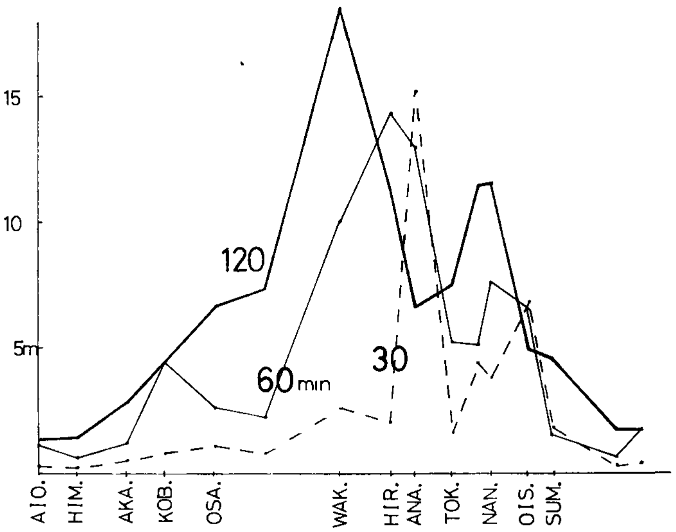

Fig. 4. The distribution of maximum computed heights along the coast of Fig. 1 (upper). The calculation is made at the periods of 30, 60 and 120 min.

height of tsunami decreases to some extent, except near Oishizaki and Anan. But when the period is 60 min., the height is over 4 m even at Kobe due to the resonance in Osaka Bay, and taller at Wakayama. When the period is 120 min., there is almost no decrease. Wakayama and Nantan particularly will experience over 10 m height.

It is realistic to consider the period of 30–60 min. as the input wave in Kii Channel, for Osaka and Hiromura (near Wakayama) has been reported to be damaged and Hyogo (near Kobe) to be safe in past big tsunami (1605, 1854).

Acknowledgements

The author wishes to express his sincere thanks to Professor Izuo Ozawa for helpful suggestions and a critical reading of the report. Computations were made on a Facom 230–60 of the Kyoto University Computing Center.

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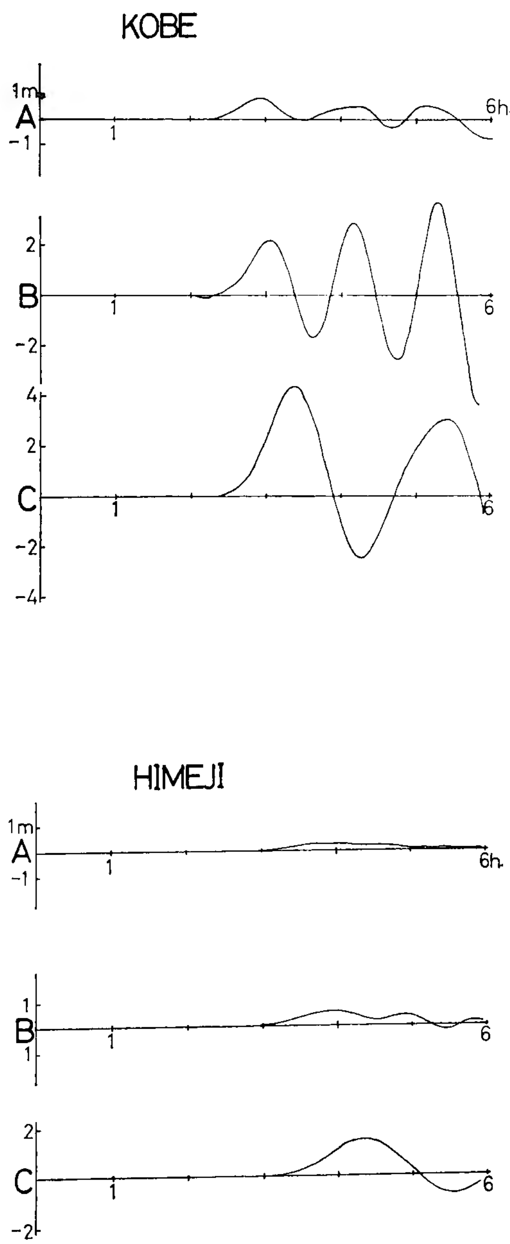
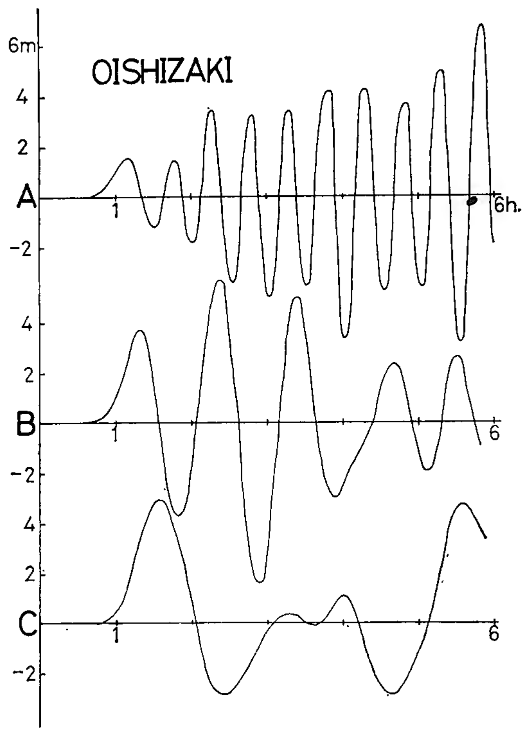
Fig. 5. Computed wave forms at various points in Fig. 1 (upper). A, B and C indicate the case of the period 30, 60 and 120 min. respectively.




OISHIZAKI
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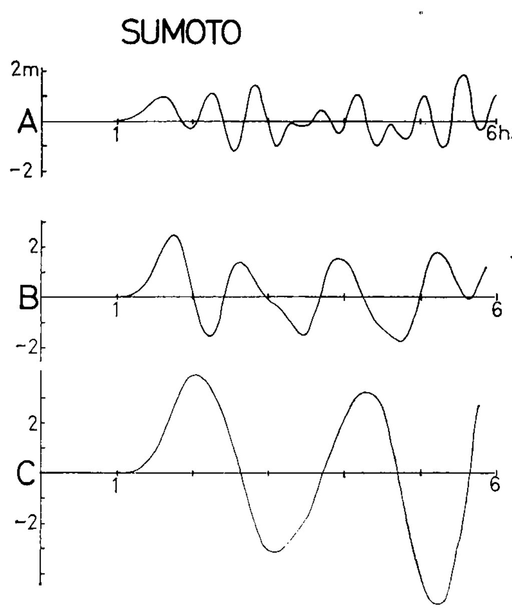
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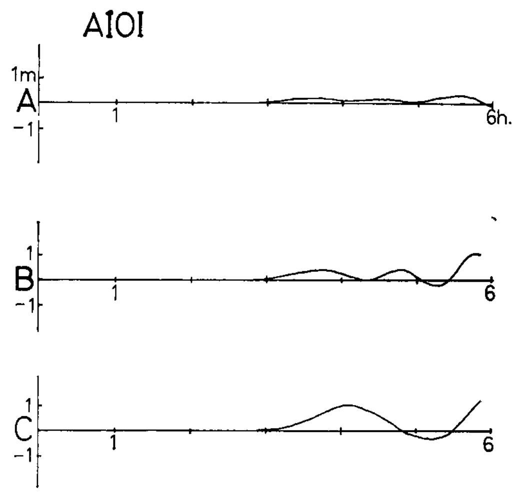
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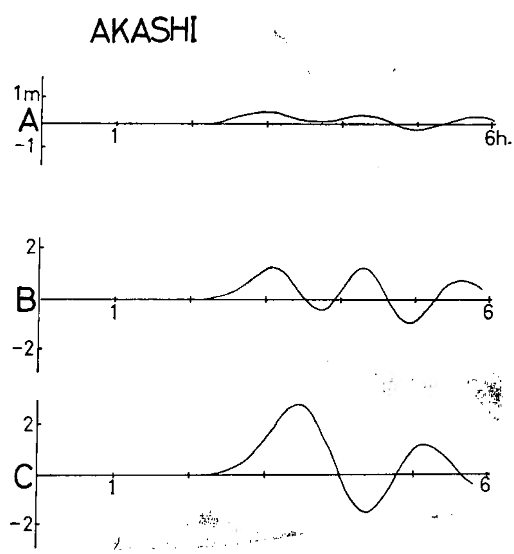
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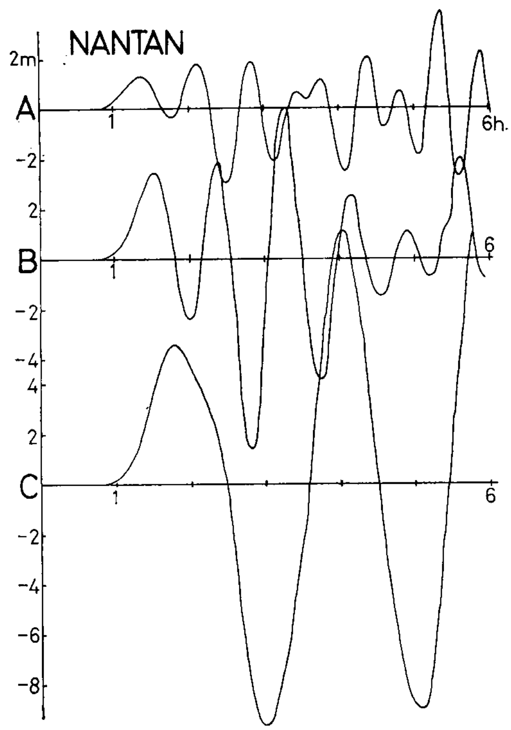
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